

6 Monthly Discharge Monitoring Records

This section of the program is where the actual treatment performance data for the facility is stored. The table that appears in the discharge monitoring application window contains column headings based on the data elements entered in the design capacity and NPDES permit parameter sections. The source of the data for this table is the monitoring results from the sampling and analysis records for the facility. The data entered in this section will typically come from the facility monthly discharge monitoring report form (IDNR Form 35-*) or from another computer spreadsheet (Excel, Lotus 1-2-3, Quattro Pro, etc) that may be used at the facility for storing and managing the daily/weekly monitoring required by the NPDES permit. It should be noted here that only the summary statistics such as monthly mean (MA), monthly maximum (MM), and 7-day maximum (7M), are entered for the individual parameters as shown in the table column headings. To enter/edit a particular cell in the table, click on the "Edit" button, select the data cell and enter the value. To move around in the table the use the up/down and right/left scroll bars on the right and bottom edge of the dialog box. When the edit feature is active, the special edit option buttons are available to facilitate working with the data elements. The "Cut", "Copy", "Paste", "Clear", "Delete/Insert Row" buttons work similarly to typical Windows compatible spreadsheets. The first step is to select a cell, or group of cells, by clicking and/or clicking/dragging the mouse to highlight the cell(s) to be edited. The copy feature can be used to select data from another source (spreadsheet) external to the ISAP file, copy the data to the Windows clipboard, and then use the "Paste" option to enter the data value(s) to the ISAP monitoring record spreadsheet.

The data in this section of the program should be carefully edited to ensure the accuracy of the data since the facility assessment computed later is directly effected by this data file. This data compare exactly with the monthly monitoring data submitted to the IDNR.

This section of the program contains several statistical analysis features to provide some data analysis capability in the program.

The linear regression option allows the user to select a specific parameter and analyze performance over a period of time. Since the parameter values will most likely vary over time, the linear regression function will calculate a best-fit straight line through the data and provide a method to examine the trend in plant performance over time. To conduct a simple linear regression for a particular set of parameter values, move to the first data point in the parameter data of interest, then click and drag down the column to highlight the rest of the data series (Note: a minimum of four data points is required). Click the "Linear Regression" button, and the best fit straight line will be computed and displayed in graphical format. The graph will display an x-y plot of the date and actual parameter data values along with the calculated best fit straight line through the data points. The discharge and/or design limit will also be displayed on the graph. The equation of the best-fit straight line ($Y = mX + b$) will be located in the legend below the graph, along with the standard error and correlation coefficient from the linear regression analysis. Standard error is a statistical measure of the variability in the data. The smaller the standard error (std deviation) the less variability (variance) in the data.

Copies of the graphs can be printed from either of the two statistical analysis options by clicking on the "Print" button. Figure 6-1 is a sample printout illustrating the features of the simple linear regression analysis. The best-fit line is shown in addition to the linear regression line plus one standard deviation. Note that the linear regression line clearly indicates an upward trend in the effluent CBOD₅ MA loading (lb/d). The user can also select the estimation feature in the linear regression application window to compute and display the dates the permit limit might be reached. This estimation uses the linear regression equation and the linear regression plus standard error for the estimation. For the data in Figure 6-1, the regression indicates the permit limit of 327 lb/d CBOD would be exceeded in May of 2005. When the standard error is factored in, the permit limit would be exceeded by October 2001.

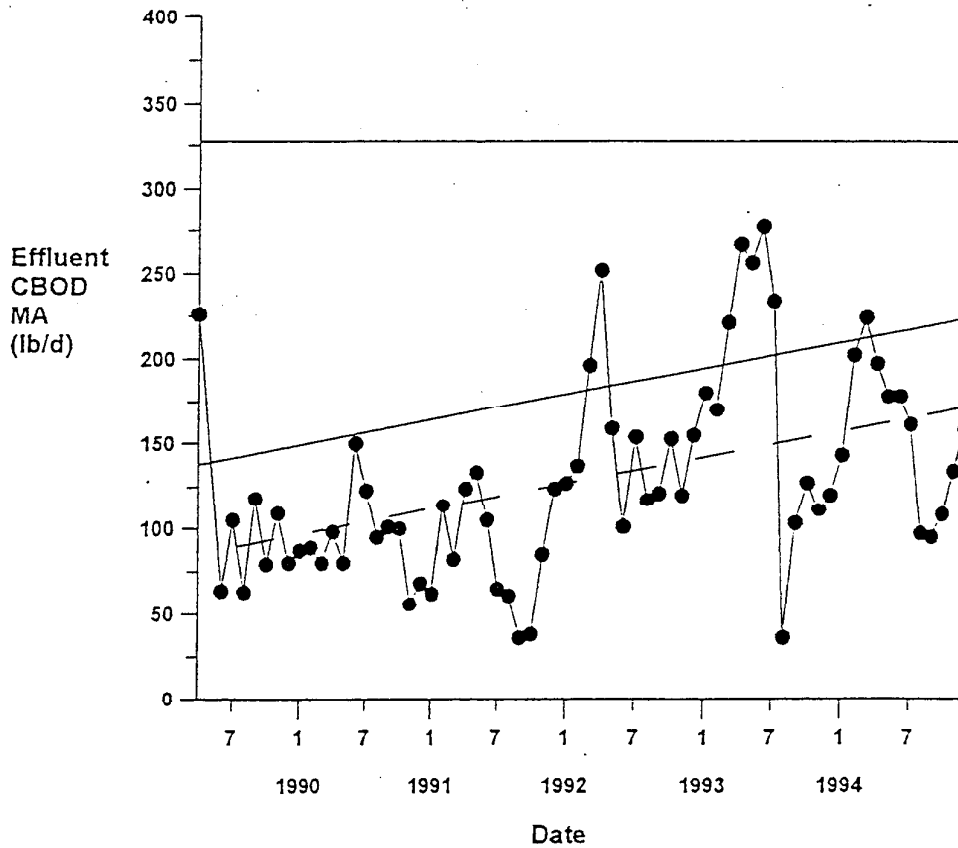
The user is reminded that no simple statistical model can completely account for all the variability inherent in the complicated processes in a wastewater treatment facility. The program user and plant manager must use judgement in interpreting the results. If the indicated trends do not seem to fit with other observations and monitoring at the plant, the frequency of monitoring data and the QA/QC of the sampling and analysis program might be examined for possible problems. The trend indicated in Figure 6-1 may not continue. However, the analysis does suggest the operator might consider the likely reasons for the upward trend in effluent CBOD₅ shown in Figure 6-1. If the sampling frequency for the monitored parameter is low (i.e. twice/week) and the plant performance is highly variable, the variance of the sample pool will be high. This will likely result in a linear regression that is less accurate in predicting the true performance of the facility. Analyzing trends in plant performance may also lead the operator to look at monitoring for additional parameters, or increase the frequency of sampling in order to identify the problem.

A large degree of variance in the data, with numerous excursions above the limit, exposes instability in the treatment process and should lead the operator to examine reasons for the poor performance. Figure 6-2 is an example of the analysis capability for effluent ammonia nitrogen concentration for a facility. As can be seen from the figure, the ammonia limits vary with season of the year. Figure 6-2 indicates the treatment facility has been successful at reducing the overall average effluent ammonia concentration as illustrated by the downward slope of the linear regression line. However, the facility is still experiencing problems meeting the seasonal variation in the permit limits.

Figure 6-3 is an example of effluent CBOD₅ concentration over time for a treatment facility. Overall, the data in Figure 6-3 indicates the treatment facility is will most likely continue having problems meeting the permit limit as indicated by the upward slope of the linear regression line and its associated standard error beyond the permit limit.

Sim City 2

Linear Regression



Effluent CBOD, MA (lb/d) = $8.55E+01 + 1.26E+00 \times (\# \text{ of Months})$

Standard Error = $5.24E+01$

Correlation Coeff. = $4.32E-01$

Data Curve

limit

Linear Fit

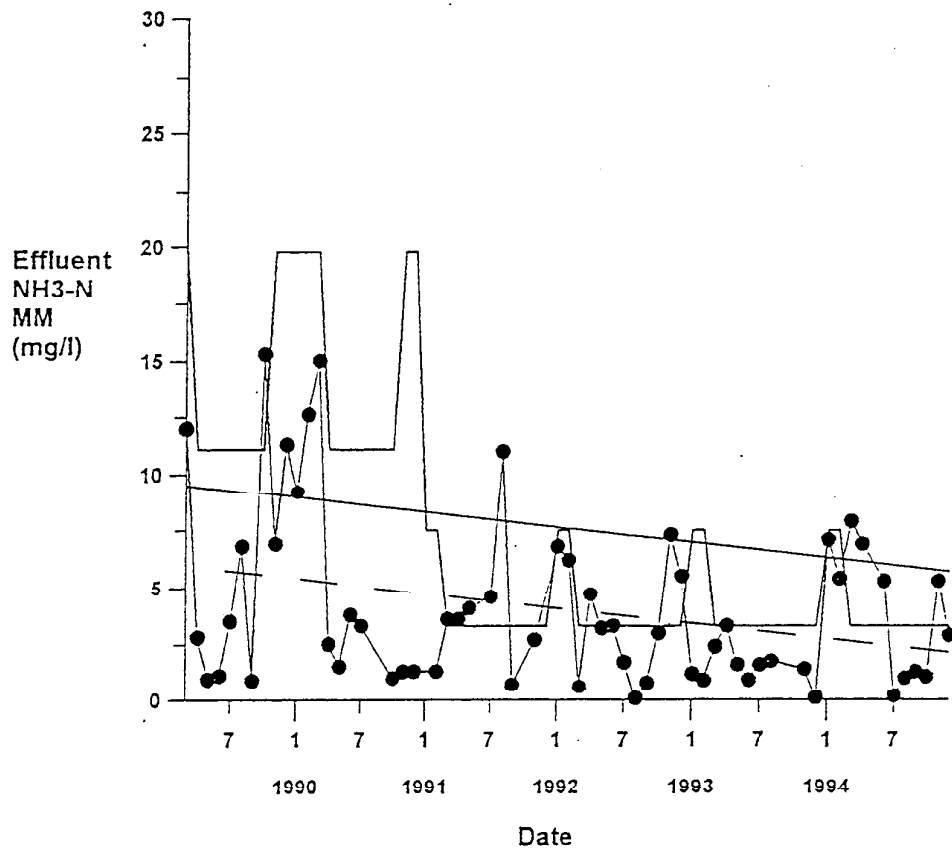
Linear Fit + SE

Date (mm/yyyy)	4/2005	10/2001
Effluent CBOD, MA (lb/d), L.F.	327.00	274.57
+ Standard Error	379.43	327.00

Figure 6-1 Example of graphing and regression capability of the ISAP.

Sim City 1

Linear Regression



Effluent NH3-N, MM (mg/l) = $5.95E+00 + -5.52E-02 \times (\# \text{ of Months})$

Standard Error = $3.57E+00$

Correlation Coeff. = $-3.10E-01$

Data Curve limit

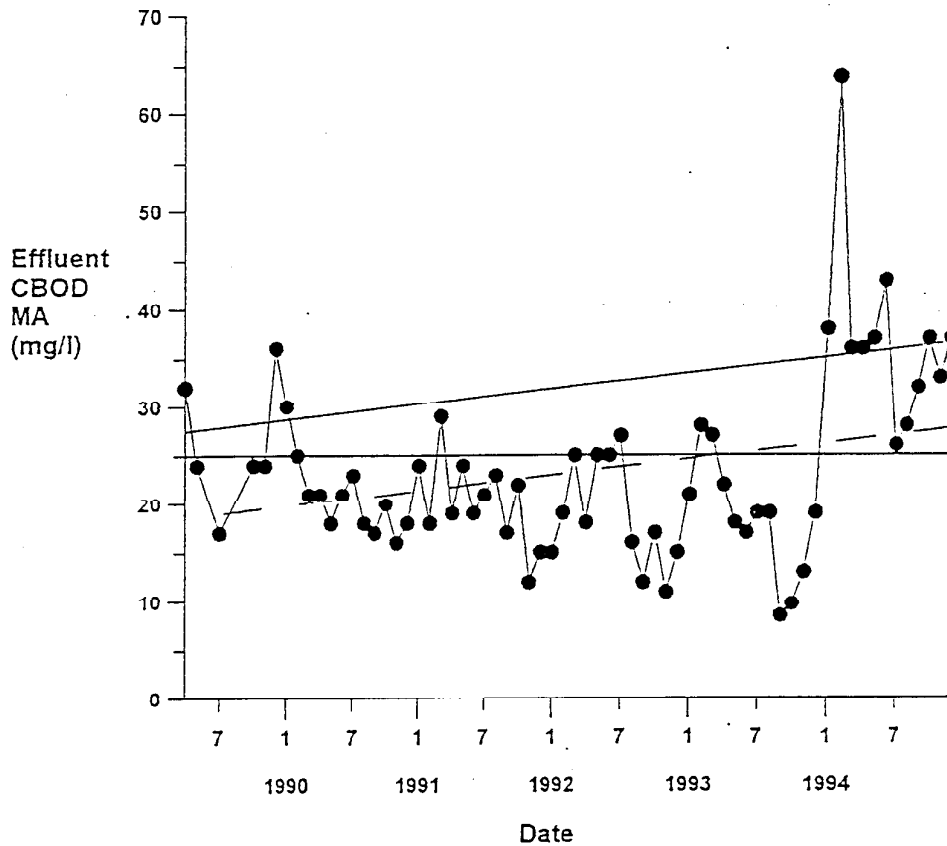
Linear Fit

Linear Fit + SE

Figure 6-2 Example of graphing and regression capability of the ISAP.

Sim City 3

Linear Regression



Effluent CBOD, MA (mg/l) = $1.86E+01 + 1.35E-01 \times (\# \text{ of Months})$

Standard Error = $8.86E+00$

Correlation Coeff. = $2.85E-01$

Data Curve limit

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Linear Fit

Linear Fit + SE

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Date (mm/yyyy)	4/1993	10/1987
Effluent CBOD, MA (mg/l), L.F.	25.00	16.14
+ Standard Error	33.86	25.00

Figure 6-3 Example of graphing and regression capability of the ISAP.

Figure 6-3 Example of graphing and regression capability of the ISAP.

The plotting capability can be used to help identify possible sources of problems with effluent limits. For example, Figure 6-4 is a plot of the facility influent CBOD₅ loading for the same period and treatment plant used in Figure 6-3. A visual comparison of Figures 6-3 and 6-4 suggests at least some portion of the increase in effluent CBOD₅ concentration is due to an increase in CBOD₅ loading to the treatment plant. In this case, additional sampling of the influent and effluent CBOD₅ loadings across the biological treatment process might reveal more specific performance issues. The problem could be the biological process, but it could also be a problem with the upstream and downstream clarifiers. Additional sampling and sound operator judgement will most likely reveal the problem. The self assessment process is designed to assist the plant operator in analyzing and managing the monitoring data to present a clearer picture of treatment performance. The end result is better compliance rates for the treatment facilities.

In addition to plotting a single parameter over time, the ISAP user can plot any two selected parameters simultaneously over time and determine a linear regression equation relating the two parameters. Figure 6-5 is an example of this capability for the data shown in Figures 6-3 and 6-4. The plot shows influent CBOD₅ monthly average loading (lb/d) to the plant and monthly average effluent concentration (mg/L). As one might expect, the effluent quality is related to the influent load in most plants. The strength of that relation will generally become more noticeable as the plant approaches its design capacity. In this example, the effluent CBOD₅ MA concentration is the dependent variable.

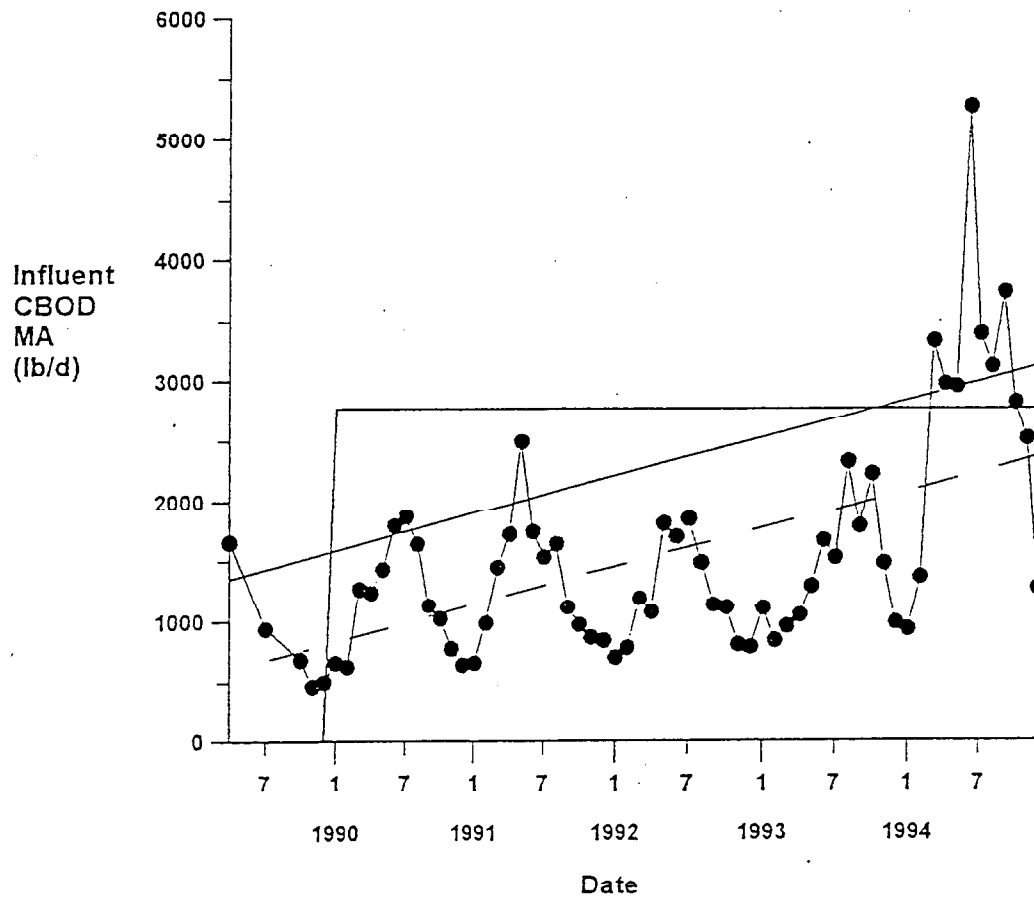
To prepare a plot similar to Figure 6-5, start at the application window for monthly monitoring records. To complete this analysis, first highlight the **dependent** parameter data series as before, then click the "Two-curves Ratio" button. A list of additional parameters will appear and the user will be prompted to select a second comparison parameter from the list. Highlight the second, **independent**, parameter then click "OK". A new graph will appear with both parameters plotted as a function of time. The respective limit for each parameter will also be indicated, in addition to some summary statistics. Also shown in the Figure 6-5 plot is the linear regression and correlation between the influent and effluent, with the influent as the independent variable. The estimation feature ("Estimation") will compute the independent variable value which results in an effluent parameter value that is equal to the effluent permit limit value. This estimation is computed for the linear regression and the linear regression plus the standard error. As an example, in Figure 6-5, the regression equation predicts the influent loading should be less than 2016 lb/d in order to meet the effluent limit of 25 mg/L, and should be less than 1027 lb/d if the standard deviation of the effluent data is taken into account. The user can input any other independent variable value and the program computes the dependent variable value for the linear regression and linear regression plus one standard deviation.

Figure 6-6 shows the correlation between the influent and effluent monthly average CBOD₅ loading for the same treatment facility used for the analysis in Figures 6-3, 6-4, and 6-5. For the selected parameters the regression equation shows the average

CBOD₅ removal rate for the treatment facility. The regression equation coefficient of 0.118 (1.18E-01) indicates that, on average, the facility removes about 88% [(1.0-.118)x100] of the CBOD₅ loading to the plant. However, the user is reminded that the correlation coefficient for the linear regression ($r^2 = 4.74E-01$) in this example is only 0.47. As the correlation coefficient, r^2 , approaches a value of 1.0, the predictive relationship between the two variables becomes more accurate. It is also useful to remember that the regression equation is based on the historical data set. The less accurate the data, the more error in the predictive capability of the regression. Also, if significant changes are made in a treatment process, or design capacity, the regression should be updated as new operating data is accumulated.

The "Print" option button in the statistical analysis menu allows the user to print the graph with or without the estimate information. When the "Print" button is clicked the next menu clearly indicates the print options.

Sim City 3 Linear Regression



Influent CBOD, MA (lb/d) = $5.96E+02 + 2.61E+01 \times (\# \text{ of Months})$

Standard Error = $7.55E+02$

Correlation Coeff. = $5.53E-01$

Data Curve

limit

Linear Fit

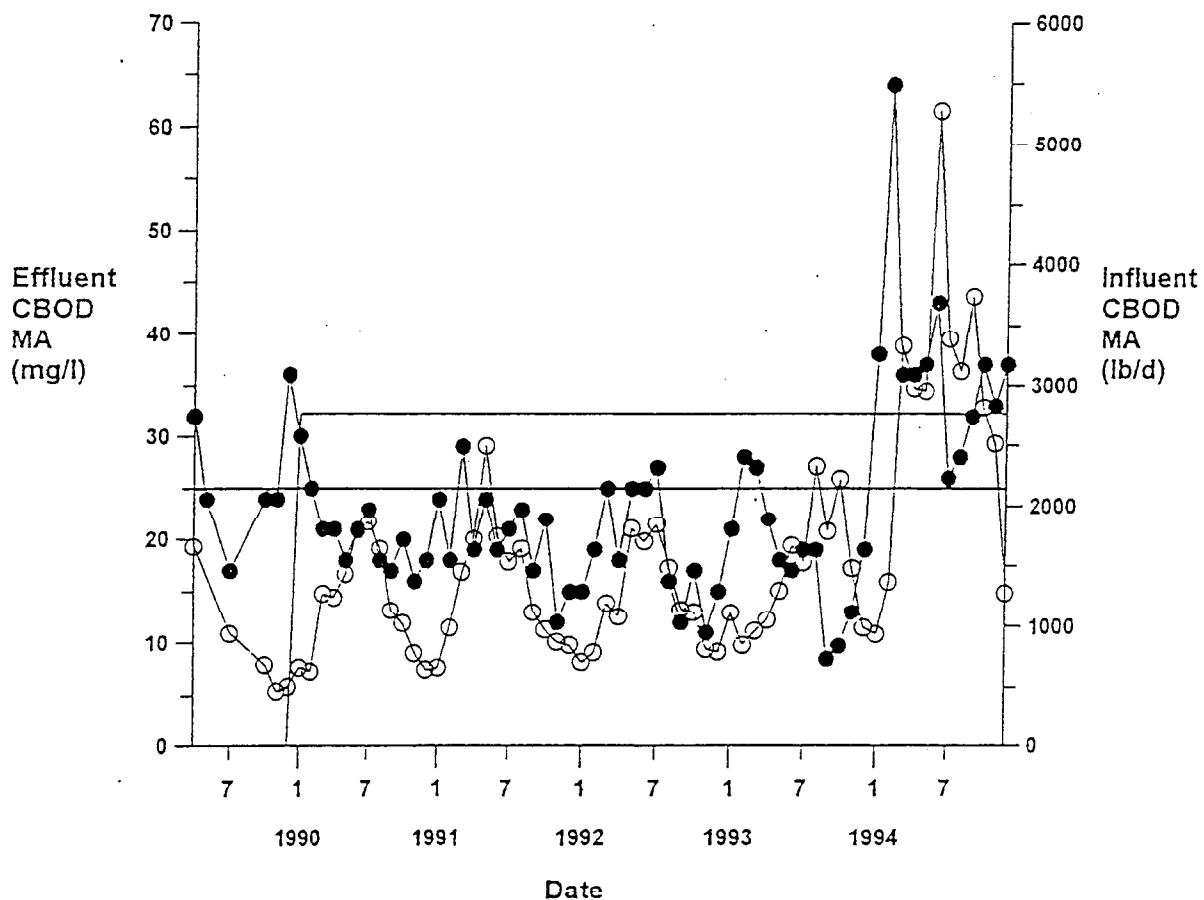
Linear Fit + SE

Date (mm/yyyy)	3/1996	10/1993
Influent CBOD, MA (lb/d), L.F.	2770	2015
+ Standard Error	3525	2770

Figure 6-4 Example of graphing and regression capability of the ISAP.

Sim City 3

Two-Curve Ratio



Effluent CBOD, MA (mg/l) = $1.24E-02 \times$ Influent CBOD, MA (lb/d)

Standard Error = $1.23E+01$

Correlation Coeff. = $3.93E-01$

Left Y Axis

limit 1

Right Y Axis

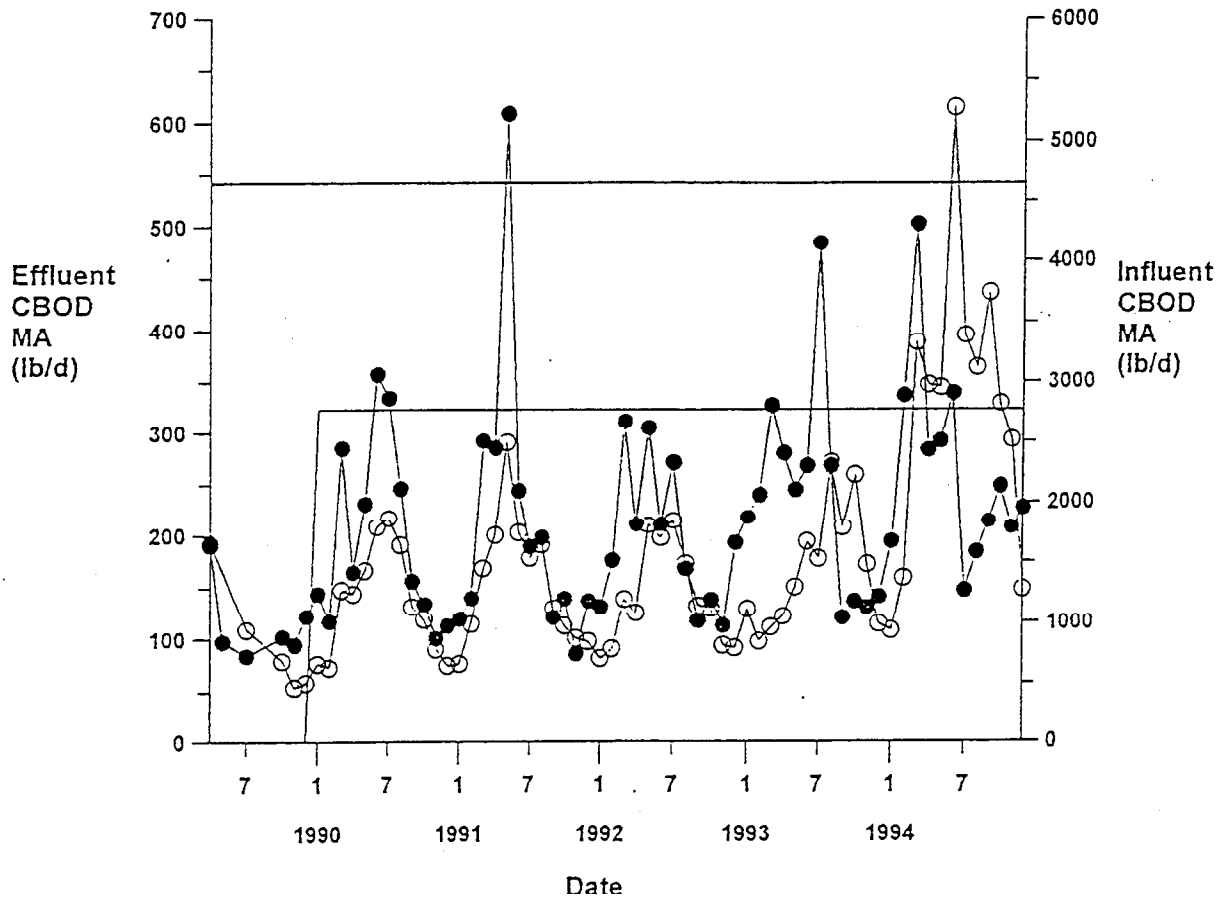
Limit 2

Influent CBOD, MA (lb/d)	2016	1027
Effluent CBOD, MA (mg/l), L.F.	25.00	12.74
+ Standard Error	37.26	25.00

Figure 6-5 Example of graphing and regression capability of the ISAP.

Sim City 3

Two-Curve Ratio



Effluent CBOD, MA (lb/d) = $1.18E-01 \times$ Influent CBOD, MA (lb/d)

Left Y Axis limit 1

Standard Error = $1.13E+02$

Correlation Coeff. = $4.74E-01$

Right Y Axis Limit 2

Influent CBOD, MA (lb/d)	4589	3630
Effluent CBOD, MA (lb/d), L.F.	542.00	428.72
+ Standard Error	655.28	542.00

Figure 6-6 Example of graphing and regression capability of the ISAP.